iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 3 **Issue:** VII **Month of publication:** July 2015

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

DVB-T/T2 Performance in Advanced Mobile TV Channels

D.S.Kumar[1], M.Suneel[2]
[1]*M.Tech student,* [2]*Assistant Professor Department of ECE*
Bapatla Engineering College, Bapatla, Andhra Pradesh, India

Abstract: The second generation terrestrial standard DVBT2 has a more flexible approach of the system parameters for the mobile and portable digital television broadcasting then DVB-T. This paper deals with the exploring of the DVB-T/T2 transmission performance in advanced mobile television channel models. For the analysis and simulation there were used advanced mobile fading channel models called Vehicular Urban and Motorway Rural that respects fast moving receiver in a car and Doppler shift. Detailed dependences of the bit error ratio before and after channel decoding and according modulation error ratio on the carrier-to-noise ratio are the main results of this work. Applications for the exploring of DVB-T/T2 performance were completely created in MATLAB.
Keywords: DVB-T/T2, advanced FEC, channel coding, advanced mobile channels, Doppler shift, BER, MER.

I. INTRODUCTION

MOBILE TV reception of video, audio and data services in high quality become more and more popular between the users. Therefore, a demand for these services in the near future will be rapidly increasing. In an era of mobile DTV (Digital TV) broadcasting there exist several types of DVB (Digital Video Broadcasting) standards, which define the methods (framing structure, encoding/decoding, modulation and transmission scenarios) of the broadcasted multimedia TV services. For the mobile TV, the DVB-T/H (Digital Video Broadcasting – Terrestrial / Handhelds), DVB-SH (DVB-Satellite to Handhelds) and newly, DVB-T2 (2ndGeneration Digital Terrestrial Television Broadcasting) standards have been recently developed. DVB-T is still a flexible system that allows to provide a wide range of different multimedia services for mobile and fixed reception. Nowadays, it is the most widely deployed DTV system worldwide. On the other side, thank to the high demand of customers for the mobile multimedia services in high quality, the DVB-T standard is not the most effective. The main reason is its low system flexibility and spectral efficiency. In order to enable a higher flexibility and efficiency, between the very perspective LTE (Long - Term Evolution), the advanced DVB-T2 standard has been developed. The mobile TV implementation aspects it is very important to determine the reception environment (e.g.). In context of mobile TV reception, the option “mobile” is associated with the reception of DTV services at medium to high speed (in general 30 km/h and higher up to 100 km/h in vehicular traffic) . Thank to this, Doppler shift is present and properties of the transmission channel change over the time. Therefore, the overall system configuration, providing the broadcasting of mobile DTV services, has dominant impact on the robustness of the transmitted signal via channel. The mobile reception suffers from all impairments relevant for portable reception (noise AWGN, multipath reception, fading, impulsive noise, Doppler shift, etc.). Therefore, mobile channel models, appropriate for the simulation, which consider mentioned impairments, are very important. In general, in this field, RA (Rural Area) and TU (Typical Urban) channel models have been used The performance of the mobile TV in DVB-T/H and DVB-SH standards has been sufficiently explored. The performance of the DVB-T2 in these channel models was also explored .The obtained results show that these channel profiles (mainly TU6 channel) seems to be more demanding than real mobile TV reception conditions.

This paper focuses on the exploring of the performance of the DVB-T/T2 systems and its critical comparison in advanced mobile channel models. There are based on real measurement data [10] and called VU30 (Vehicular Urban) and MR100 (Motorway Rural) channel models. The structure of this paper is organized as follows. After the introduction, a brief theoretical background and main characteristics of the used channel models are shortly described in Section II. The parameters and typical scenarios for the analysis and simulation are presented in Section III. Section IV contains graphical dependences of the BER(Bit Error Ratio) before and after Viterbi decoding (DVB-T) and before and after LDPC decoding (DVB-T2) and MER(Modulation Error Ratio) on C/N ratio and their discussion. Finally, the paper concludes in Section V. The differences between the present (DVB-T) and

Volume 3 Issue VII, July 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

upcoming (DVB-T2) standards for terrestrial broadcasting are significant. DVB-T2 uses an advanced and very flexible FEC scheme coding, offers a very robust signal. Several new option parameters are available in DVB-T2 standard, in contrast with DVB-T, such as the number of transmission modes (1K, 4K, 16K and 32K), and GI (Guard Interval) sizes (19/256, 18/128, and 1/128).

II. OVERVIEW OF THE DVB-T AND DVB-T2 STANDARD

A. DVB-T Standard

The structure of the transmitter follows common DVB-T transmitter block diagram, as shown in Fig. 1. Details of the following blocks are briefly described below. At the input, the data are randomized to ensure adequate binary transitions. To achieve energy dispersal, PRBS (Pseudo Random Binary Sequence) is first generated and then mixed with the data stream by means of an XOR (Exclusive OR) operation, which breaks up long sequence of ones or zeros . The next stage contains FEC encoder blocks and puncturing. Firstly, the outer and so called, RS (Reed Solomon) encoder is applied. This encoder RS (204,188) adds 16 correction bytes to 188 input bytes and it is able to correct up to erroneous bytes. After that, the data are interleaved. An outer inter leaver is a convolutional . The outer inter leaver is followed by the inner encoder, so called, convolutional encoder. The generator polynomials are G1=171OCTand G2=133OCT. If necessary, the error protection can be controlled by puncturing, e.g. the data rate can be lowered again by selectively omitting bits.

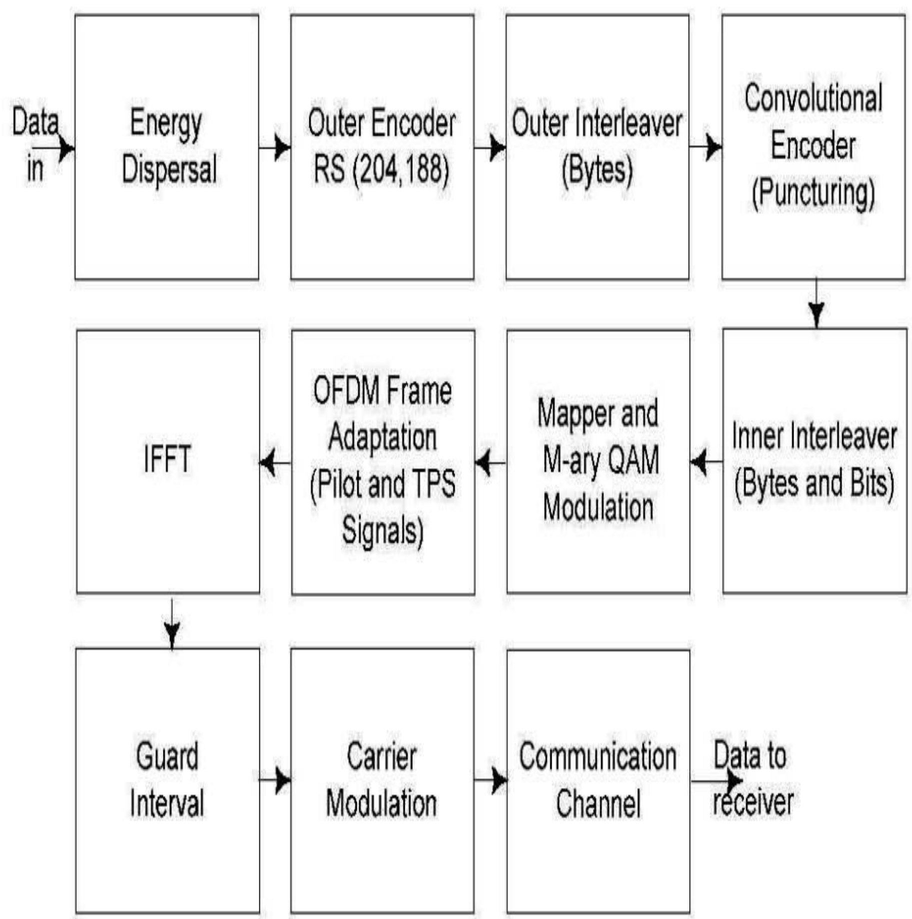


Fig. 1. Functional block diagram of the DVB-T transmitter.

The next block, inner interleaving, is divided into two steps: bit and symbol interleaving. The input stream is demultiplexed into ν sub-streams, depending of the modulation used: ν= 2 for QPSK, ν= 4 for 16QAM and ν= 6 for 64QAM. Symbol interleaving is performed as bit-wise interleaved sub-stream. The purpose of the symbol inter leaver is to map ν bit words onto the 1512 (2K mode) or 6048 (8K mode) active carriers per OFDM symbol. After previously mentioned FEC blocks, symbols from output inner inter leaver are ready to modulate into QPSK, 16QAM or 64QAM constellations. Transmission frame adaptation block has to divide modulated stream, carrying useful data, into OFDM symbols and to add the pilots and signaling carriers. Once we have OFDM symbols assembled and converted to the time domain by IFFT (Inverse Fast Fourier Transformation) operation, guard interval can be inserted. The end part of each symbol is copied to the beginning of the present symbol. Real and imaginary parts of the OFDM signal are up sampled and filtered with RRC (Root Raised Cosine filter with roll-off factor equal to 0.35. At this point we have now prepared DVB-T signal, which can be transmitted.

B. DVB-T2 Standard

The structure of the transmitter follows common DVB-T2 transmitter block diagram, as shown in Fig. 2. And again, details of the following blocks are shortly described below. As can be seen in Fig. 2, the first module of such a system is the input processing module. This module converts the input data stream into DVB-T2 baseband frames (BBFRAMES). The baseband frames shall be processed by the FEC coding subsystem. The first remarkable novelty can be found in the advanced error correction scheme.DVB-T2 uses LDPC (Low Density Parity Check) coding, combined with BCH (Bose- Chaudhuri-Hocquengham) coding, which offer excellent performance resulting in a very robust signal reception. The output of encoded data should be bit interleaved, which consists of parity interleaving, followed by so called column twist interleaving. The bit interleaved data are then mapped to coded and modulated FEC blocks by the map bits onto constellation module. Of course, in DVB-T2 standard, how it is in DVB-T too,

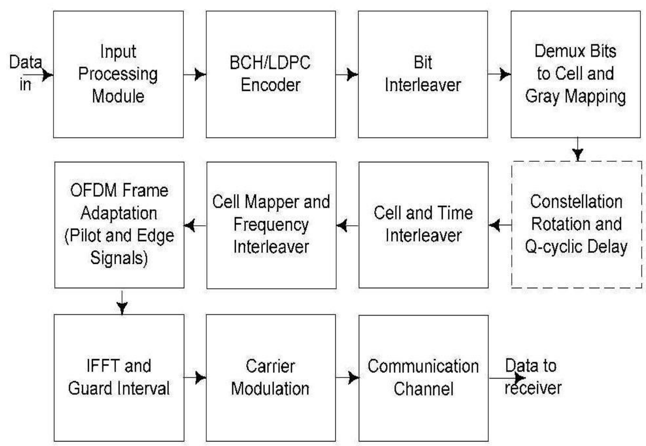


Fig. 2. Functional block diagram of the DVB-T2 transmitter.

Gray mapping is used. DVB-T2 system also allows an optional module, so called constellation rotation with cyclic Q-delay. This is a novel technique to resist the transmission channel with deep fading’s. After the mapping, cell and time inter leavers are the next stage. Cell inter leaver spreads the cell words of a FEC block. In the block of time inter leaver, cells of groups of FEC blocks, making up T1-blocks, which turn make up interleaving frames, are interleaved. Cell-mapper assembles the modulated cells into arrays corresponding to OFDM symbols. The next block is a frequency inters leaver. The purpose of the frequency inter leaver, operating on the data cells of one OFDM symbol, is to map the data cells from the frame builder onto available data carriers (depending on the OFDM modes – 1K, 2K, 4K, 8K, 16K and 32K) in each symbol. As seen in Fig. 2, next block, as in case of DVB-T, is the OFDM frame adaptation. The function of this block is the same as in DVB-T. And again, after the signal conversion from frequency to time domain

(IFFT operation), guard interval can be inserted. After the carrier modulation (RRC filtering and IQ modulation), DVB-T2 signal is prepared and it can be transmitted in broadcasting network.

III. ADVANCED MOBILE CHANNEL PROFILE MODES

Distribution of the DVB-T/T2 mobile TV multimedia services by way of terrestrial transmitters is the classical technology of broadcasting. Received signal should be interpreted as the overall effect, the sum of various influences created by noise, interference and Doppler shift, caused by path loss, delay, speed of the receiver and type of distribution (spectrum) of each group of on unresolved echoes. As it was mentioned above, nowadays used mobile and portable channel models have several disadvantages. The most important of them is a fact that there are problems to describe especially slow/fast reception in urban and rural area with these models. Therefore, a set of "new" channel models have been developed and created as a result of the earlier Finnish Wing-TV test .

A. VU30 (Vehicular Urban)

The basis of the new channel models were real measurement data in real environment, which was acquired from extensive DVB-T/H field measurements . These measured data were studied extensively and the most important parameters (path loss, delay, number of taps, K-factors and Doppler shift/spread) were obtained. As a result, there were created two new channel models, marked as VU30 and MR100 for the modeling of real environment in urban and rural area, respectively. As it was mentioned above, VU30 channel model has been developed as a Vehicular Urban area profile. It is made of 12 paths. Originally, there were created a model with 24 paths. Reduction to 12 taps was accomplished by using localized delays and power estimation. More details can be found in. The number in the abbreviation of the name of the channel marks the considered speed of the receiver in km/h. Thank to this lower speed, the caused Doppler shift is less.

B. MR100 (Motorway Rural)

This profile reproduces the terrestrial propagation in a rural area. The MR100 channel model also consists of 12 independent paths. On the other side, compare to VU30 model, in the MR100 model the paths have shorter delays and higher losses. On the other hand, in both channels, the first path is considered as a path with zero path loss and zero delay. Moreover, in this channel the speed of the receiver is considered around 100 km/h. Therefore, the Doppler shift will be minimally three times higher, as it is in the VU30 model. Thank to this, it can be expected that in this environment will occur worse results, as it will in the VU30 model.

IV. MOBILE SCENARIO AND SIMULATION PARAMETERS

The system configurations of the DVB-T/T2 standards, which were used for our simulation of their performances in VU30 and MR100 channels, are summarized in Tab. III. As it was mentioned before, the DVB-T2, in comparison with previous standards, has a very flexible system configuration with many adjustable parameters. Furthermore, there exists a special profile DVB-T2-Lite that is especially designed for the mobile broadcasting. On the other hand, when we want to conclusively compare DVB-T with DVB-T2 performance, then the used system configurations should be the same. Therefore, the same CR (Code Rate), useful data rate, OFDM mode, inner modulation (non-rotated) and GI (Guard Interval) was chosen for both standards. The system configuration of both standards should also respects the features of the advanced channel models. How it can be seen in Table I and II, the max path delay in VU30 channel is equal to 12.6 us. Hence, the CR was set on 2/3 and the length of the guard interval is equal to 1/4. In used system configurations duration of the GI interval is 56 us for both (DVB-T/T2) standards. These values are enough for the minimizing of the possible ISI (Inter symbol Interference). Furthermore, we consider that the used carrier frequency is equal to 626 MHz (channel CH40, UHF band). Therefore, the max Doppler shift in MR100 channel is equal to 57.99 Hz. This is the reason, why there is used a 2K OFDM mode with 16QAM modulation in the setup. In the DVB-T2 system configuration there is a possibility to set the number of decoding processes. Based on the transmission scenarios and our previous experience, this value was set on 20. Applications for the simulation of the DVB-T/T2 performances were completely created in MATLAB. The mentioned channel models were implemented separately.

Volume 3 Issue VII, July 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

V. SIMULATIONS RESULTS

Simulation results of the mobile TV transmission in the DVB-T/T2 standards for a varying C/N ratio in the VU30 and MR100 fading channel models were obtained and there are shown in Fig. 3 to Fig. 8. As a reference channel, a classical Gaussian (AWGN) channel was used. For the assessment of the correctly received mobile TV service the QEF (Quasi-Error-Free) operation was used , However, this operation and its limits for DVB-T/T2 standards are different. The QEF operation for the DVB-T system is defined as a bit error rate after Viterbi decoding less or equal to 2·10-4. On the other hand, for the DVB-T2 system the QEF limit is defined at 1.10-7after LDPC decoding [5]. Furthermore, this limit can be achieved at different C/N ratio, which is always depending on the applied number of decoding processes (number of iterations). In this paper, based on the transmission scenarios and features of the used channel models, the number of iteration was set on 20 Dependences of BER before Viterbi decoding in Gaussian (reference) and in mobile fading channels (VU30 and MR100) for the DVB-T are shown in Fig. 1. In the Gaussian channel, the shape

TABLE 1

DVB-T/T2 SETTINGS USED FOR THE MOBILE TV TRANSMISSION

Settings	DVB-T	DVB-T2
Code Rate (CR)	2/3 (RS+CR)	2/3 (LDPC+BCH)
FEC Frame	188 Byte	64800 Bits
Useful Data Rate	13.27 MBit/s	14.53 MBit/s
Modulation	16QAM (non-rotated)	16QAM (non-rotated)
OFDM Mode	2K (mobile)	2K (mobile)
Pilot Pattern	-	PP1
Guard Interval	1/4 (large network)	1/4 (large network)
Channel Models	Gaussian (reference) VU30 and MR100 (mobile)	
Method of Decoding	Viterbi (hard decision)	LDPC (20 iterations)

of the curve has a typical waterfall effect, because there is available only Gaussian distribution of the amplitude. How it was mentioned above, the VU30 and MR100 channel models were determined from the real measurement data and they give more realistic and credible picture about the mobile television signal propagation. Moreover, they have very similar features. Therefore, the obtained results are similar too. Features of both channel models (Doppler shift and spectrum) have high impact on the performance of DVB-T, because the error rate is reduced very slowly and linearly. At 40.0 dB of C/N ratio the BER is equal to 2.6.10-4in VU30 and 5.10-4in MR100 channel, respectively.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

The same dependences were obtained for the proposed DVB-T2 system configuration. The BER ratio before the LDPC decoding (see Fig. 4), in comparison with DVB-T, are slightly worse. More precisely, the distance between the VU30 and MR100 curves is a little bit higher. On the other side, at 40.0 dB of C/N ratio the error rate is equal to 1.9.10-4for VU30 channel and 3.8.10-4for MR100 channel, respectively. Surprisingly, the BER after the LDPC decoding (see Fig. 5) is very similar, in comparison with DVB-T. How it was mentioned above, with the LDPC decoding the number of decoding processes is adjustable.

The shape of curves after the channel decoding is very similar to curves, obtained for DVB-T system. For the better comparison, there are presented two C/N values: one for the DVB-T QEF limit (2.10-4) and one for the DVB-T2 QEF limit (1.10-7). From the results of simulation can be clearly seen that these limits can be achieved at 19.5 dB and 21.0 dB in VU30 channel and 20.5 dB and 22.5 dB in MR100 channel, respectively. It is very interesting that these C/N values are achieved after only 20 decoding processes. From this can be clearly seen that the DVB-T2 system conception in these channel models is not effective, when only a simple (one) decoding process is applied. On the other side, when the iteration number is higher, then the QEF limit can be achieved with significantly less value of the C/N ratio. Finally, dependences of the MER on C/Nin the DVB-T/T2 for all channels are shown in Fig. 3 and Fig. 6. In the area of DVB, MER is a measure of the sum of all interference effects, occurring in the digital television transmission link. Generally, higher MER[dB] means less fading in the transmission. The minimal value (MIN), necessary to achieve both QEF operation (2.10-4 or 1.10-7) limits, is marked in the graphs by dashed line. How it can be seen, the behavior of all curves for both standards is practically the same, but the achieved results in DVB-T2 system are slightly better than in DVB-T standard.

COMPARISON OF THE C/N FOR QEF IN DVB-T/T2 STANDARDS

Standard	Channel Model	ETSI [2], [5] C/N [dB]	Simulated[1] C/N [dB]	Simulated[2] C/N [dB]
DVB-T	AWGN	11.4	12.5	15.0
	VU30	-	19.1	23.0
	MR100	-	19.9	24.0
DVB-T2	AWGN	8.9	9.8	10.1
	VU30	-	19.5	21.0
	MR100	-	20.5	22.5

1 – Required (simulation) values for the QEF operation with limit 2.10^{-4}
2 – Required (simulation) values for the QEF operation with limit 1.10^{-7}

Values, needed for the QEF operation in all channel models for the DVB-T/T2 standards are clearly summarized in Table IV. There are also presented the required C/Nvalues for both QEF operation limits (2.10-4 or 1.10-7).

Volume 3 Issue VII, July 2015
ISSN: 2321-9653

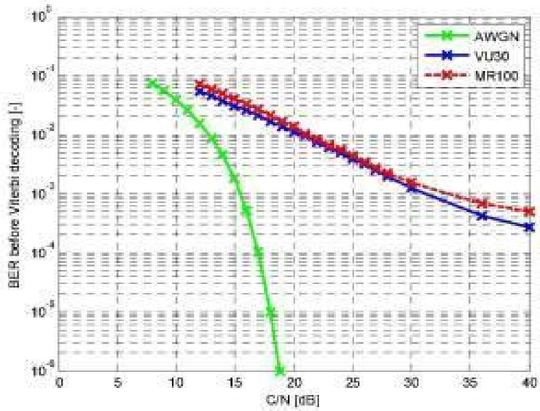


Fig. 1. Mobile reception scenario (16QAM, mode 2K, CR 2/3 and GI 1/4) and DVB-T performance (*BER* before Viterbi decoding as a function of *C/N* ratio) in VU30 and MR100 channel profiles.

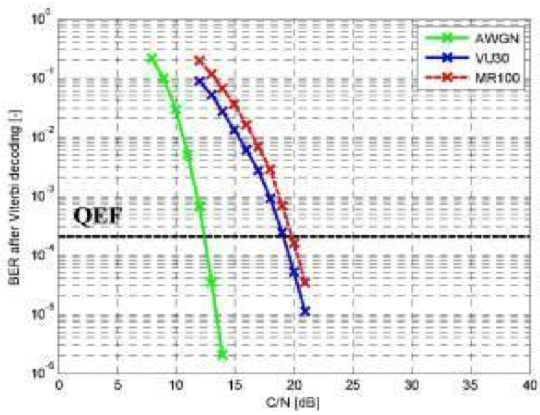


Fig. 2. Mobile reception scenario (16QAM, mode 2K, CR 2/3 and GI 1/4) and DVB-T performance (*BER* after Viterbi decoding as a function of *C/N* ratio) in VU30 and MR100 channel profiles.

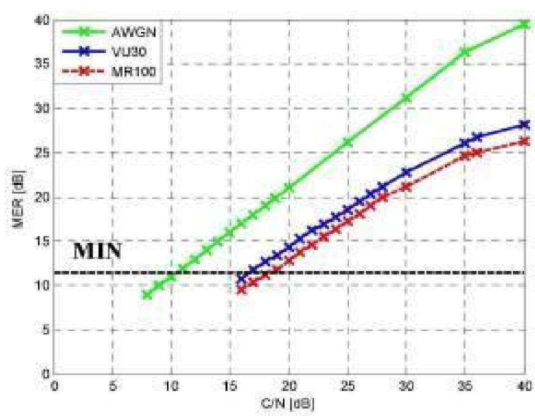


Fig. 3. Mobile reception scenario (16QAM, mode 2K, CR 2/3 and GI 1/4) and DVB-T performance (*MER* as a function of *C/N* ratio) VU30 and MR100 channel profiles.

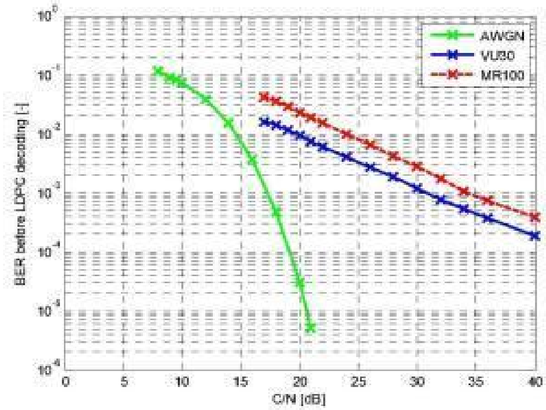


Fig. 4. Mobile reception scenario (16QAM, mode 2K, CR 2/3 and GI 1/4) and DVB-T2 performance (*BER* before LDPC decoding as a function of *C/N* ratio) in VU30 and MR100 channel profiles.

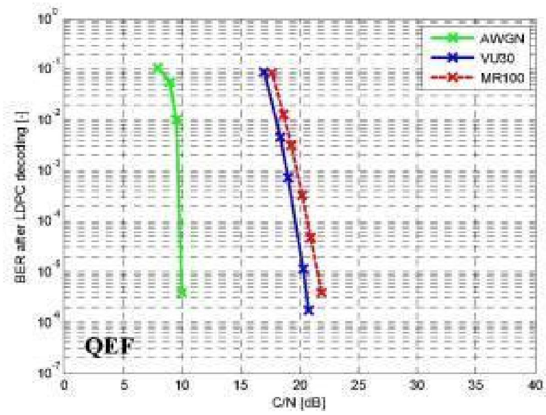


Fig. 5. Mobile reception scenario (16QAM, mode 2K, CR 2/3 and GI 1/4) and DVB-T2 performance (*BER* after LDPC decoding as a function of *C/N* ratio) in VU30 and MR100 channel profiles.

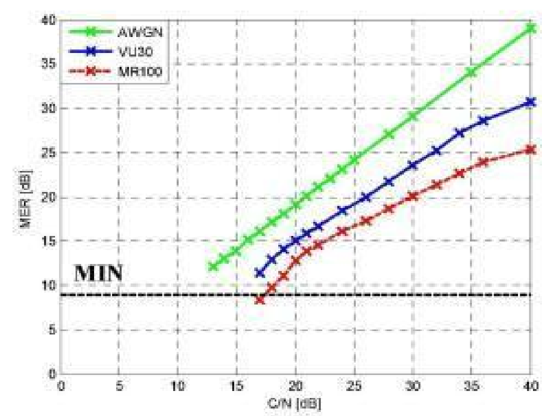


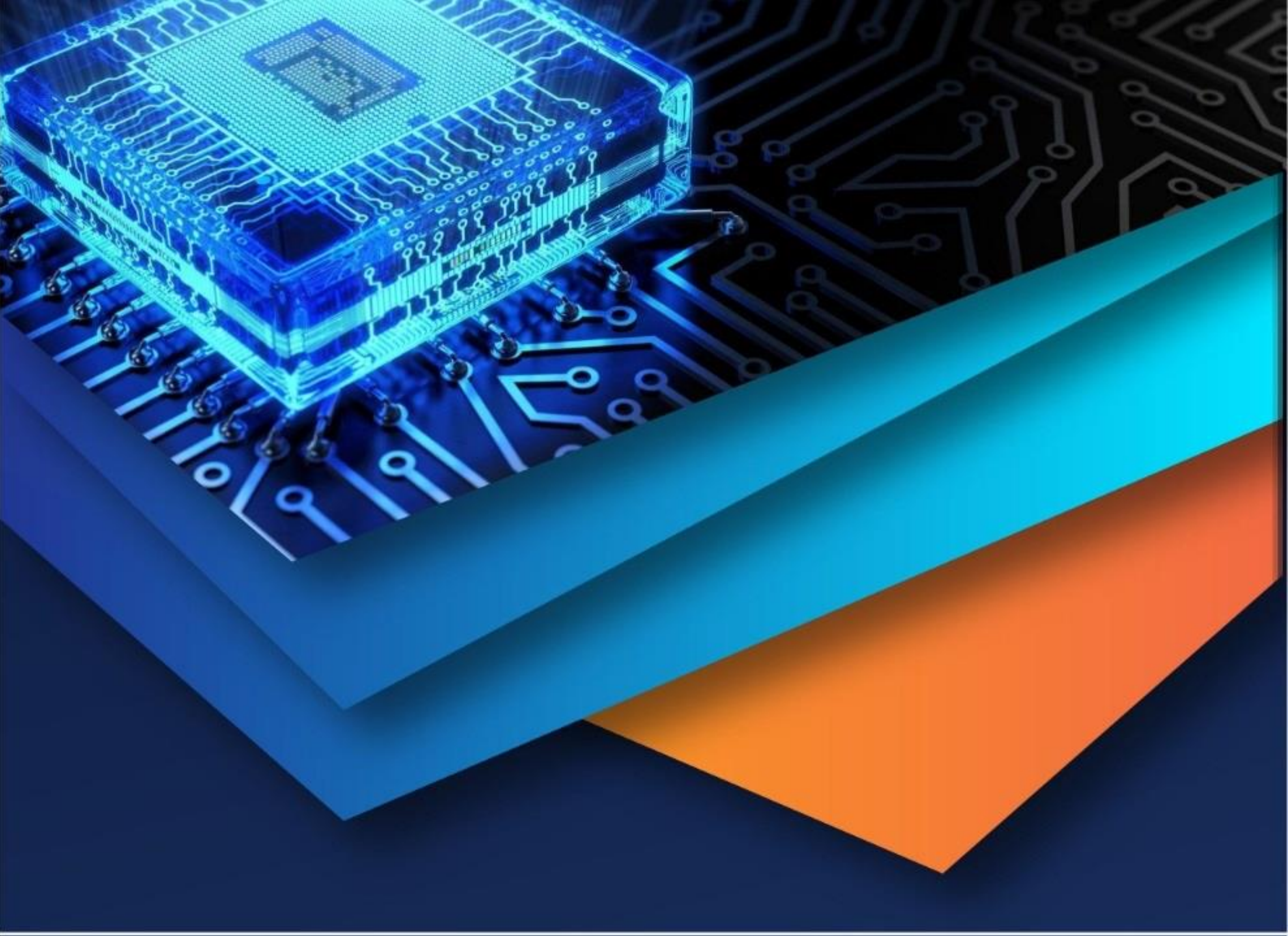
Fig. 6. Mobile reception scenario (16QAM, mode 2K, CR 2/3 and GI 1/4) and DVB-T2 performance (*MER* as a function of *C/N* ratio) VU30 and MR100 channel profiles.

VI. CONCLUSION

In this paper the performance of the DVB-T and DVB-T2 standards in mobile TV channel models were explored. Dependences of the BER before and after channel decoding and MER on C/N ratio were evaluated for both standards in two advanced mobile fading channels (VU30 and MR100), based on the real measurement data. From the results it can be assumed that the performance of DVB-T2 system with "classical" simple decoding process (if the iteration number is equal to 1), in comparison with DVB-T, is slightly worse. Of course, this disadvantage can be improved with increase of the repetition of the decoding processes (number of iterations). In our simulations, mainly based on our previous experience, the error rates are achieved after the 20thdecoding. The second possible for the minimizing of the error rates at constant C/N values is the use of the rotated constellation that increases the performance of DVB-T2 system in fading channels . How it was outlined in, the limits of the possible decoding processes at LDPC decoding are depending on the hardware complexity of the receiver. This and the impact of the rotated constellation on the performance of DVB-T2 system will be explore and discuss in our near future work and forthcoming papers.

REFRENCES

[1] EN 300 744 V1.6.1 (2009-01). Digital Video Broadcasting (DVB); Frame structure, channel coding and modulation for digital terrestrial television, European Standard ETSI, 2009.
[2] TR 101 190 V1.3.2 (2011-05). Digital Video Broadcasting (DVB); Implementation guidelines for DVB terrestrial services; Transmission aspects, Technical Report ETSI, 2011.
[3] EN 302 583 V1.2.1 (2011-12). Digital Video Broadcasting (DVB); Frame structure, channel coding and modulation for Satellite Services to Handheld devices (SH) below 3 GHz, European Standard ETSI, 2011.
[4] EN 302 755 V1.2.1 (2012-04). Digital Video Broadcasting (DVB); Frame structure channel coding and modulation for a second generation digital terrestrial television broadcasting system (DVB-T2), European Standard ETSI, 2012.
[5] TS 102 831 V1.2.1 (2012-08). Digital Video Broadcasting (DVB); Implementation guidelines for a second generation digital terrestrial television broadcasting system (DVB-T2), Tech. Report ETSI, 2012.
[6] DVB Bluebook A160 (2012-11). Digital Video Broadcasting (DVB); Next Generation broadcasting system to Handheld, physical layer specification (DVB-NGH), Bluebook ETSI, 2012.
[7] D. Astely and et al., "LTE: The Evolution of Mobile Broadband," IEEE Communication Magazine, vol. 47, no. 4, pp. 44-51, Apr. 2009.
[8] I. Ezimendi et al., "Next Generation of broadcast multimedia services to mobile receivers in urban environments," Signal Processing Image Communication, vol. 27, pp. 925-923, Dec. 2012.
[9] T. Kratocvhil, "DVB-T/H Portable and Mobile TV Performance in the New Channel Profiles Modes in Performance in the New Channel Profiles Modes". Communications Infrastructure, Systems and Applications, London, UK: Springer, Institute for Computer Science, Social-Informatics and Telecommunications Engineering, 2009, pp. 164-174.



10.22214/IJRASET

INDEX COPERNICUS

45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY